Uncovering the Extent of the Crisis in Flint

Marc Edwards, Virginia Tech

EPA-R5-2018-006908_0000383

Grateful acknowledgement

- National Science Foundation, RAPID Grant #1556258
- **Citizens of Flint**
- WaterYouFightingFor? (Melissa Mays and LeeAnne Walters)
- **Hurley Medical Center (Mona Hanna-Attisha and others)**
- US EPA Region 5 (Miguel Del Toral)
- ACLU of Michigan (Curt Guyette, Kate Levy)
- Sen. Jim Ananich, Congressman Dan Kildee (and their extraordinary staff)
- 800+ donors supporting our work
- Michigan State Health Department // Genesee County Health Department
- Democracy Defense League (Nayyirah Shariff, Claire McClinton, Dr. Laura Sullivan)
- Northeast-Midwest Institute (Elin Betanzo)
- Concerned Pastors for Social Action (Pastors Alfred Harris, Allen Overton)
- US EPA (Michael Schock and Darren Lytle)
- City of Flint (Mayor Karen Weaver, Dayne Walling, Howard Croft, Mike Glasgow)
- Members of the media
- **Virginia Tech (staff and students)**

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April 2014 “Here’s to Flint," Mayor Dayne Walling said as he raised a glass of water during a small ceremony at Flint’s water plant. “This is an historic step for us,"

http://michiganradio.org/post/flint-nears-anniversary-switch-flint-river-tap-water#stream/0

Flint Water is very corrosive.

Detroit water is not.

Table 1. Water quality parameters for drinking water supplied in Flint, MI before and after the April 2014 switch

Parameter	Before[1]	After[2]
pH	7.38	7.61
Hardness (mg/L as $CaCO_3$)	101	183
Alkalinity (mg/L as $CaCO_3$)	78	77
Chloride (mg/L)	11.4	92
Sulfate (mg/L)	25.2	41
CSMR[3]	0.45	1.6
Inhibitor (mg/L as P)	0.35	NONE
Larson Ratio[4]	0.5	2.3

[1]Source: City of Flint Monthly Operation Report, June 2015. Available from www.cityofflint.com

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Old Infrastructure +
No Corrosion Control +
Corrosive Water =

Lead +

Legionella +

Leaks

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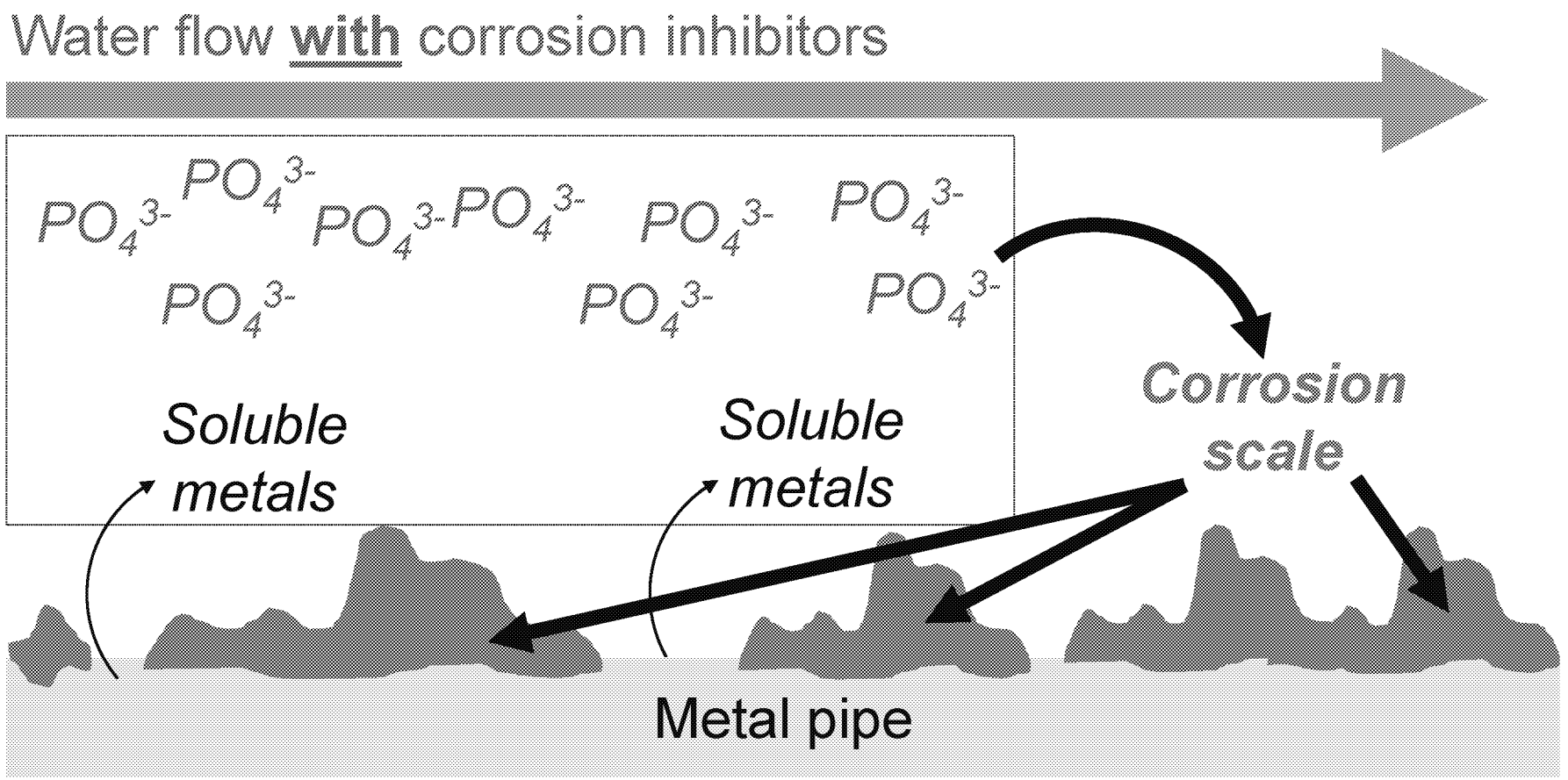
Dr. Kelsey Pieper
Min Tang

Formation of protective scales



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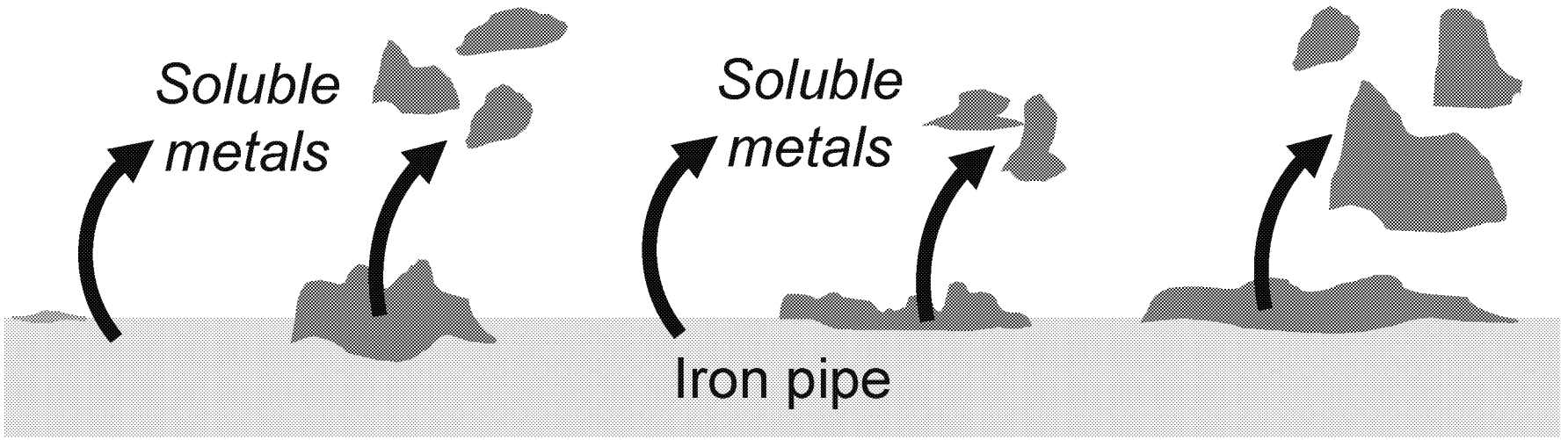
Destabilization of protective scales

Water flow **without** corrosion inhibitors

Mobilization of corrosion rust layers



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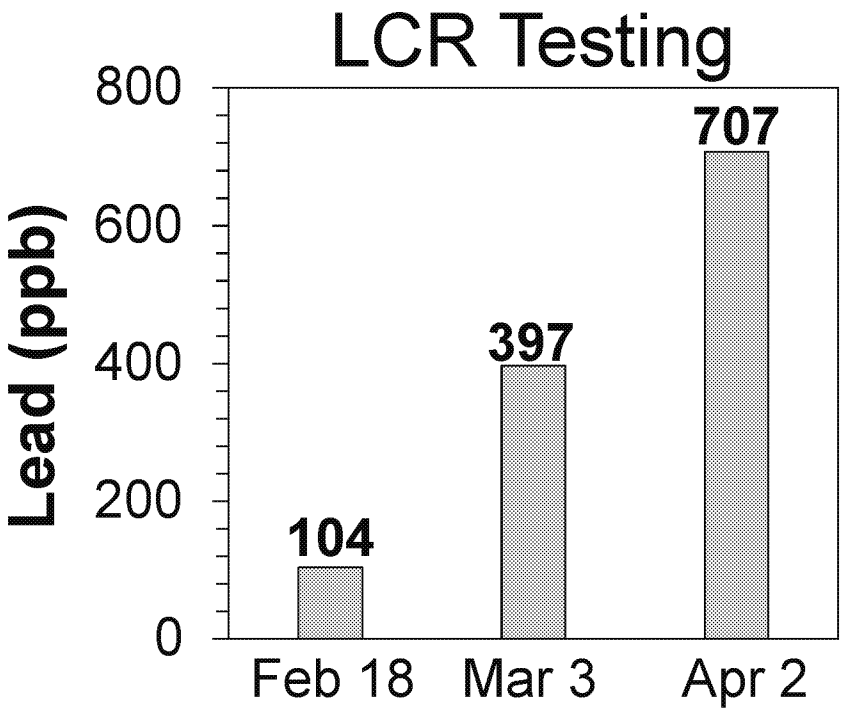
Investigation of home of "resident zero" in Flint, Michigan

Jan 2015: Homeowner collected water samples to illustrate aesthetic problems



Apr 3: City turned off water supply due to lead results

Apr 28: Virginia Tech began investigating the nature of metal release

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Investigation at Resident Zero

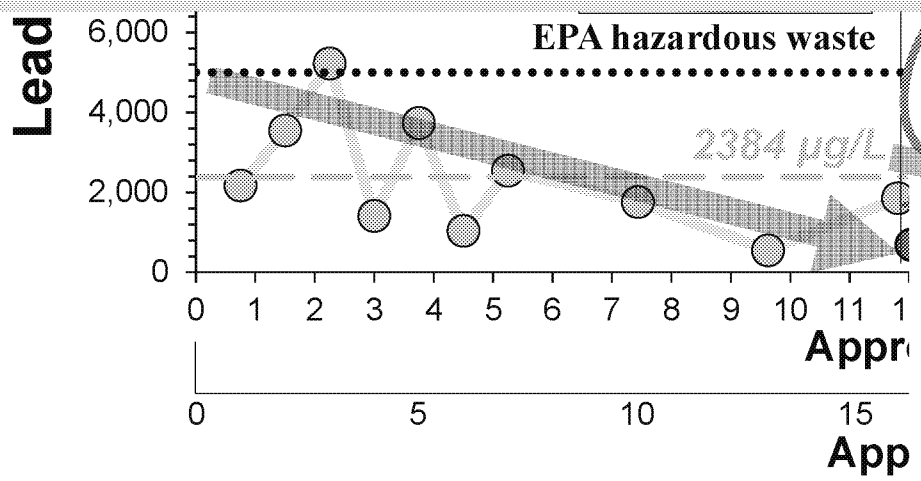
Objective was to assess nature of metal release

- Used lead profiling techniques with varying flow rates

Low flow

Every sample contained phosphate

Hadn't been added to distributed water for 11 months



Lead was decreasing with continued flushing

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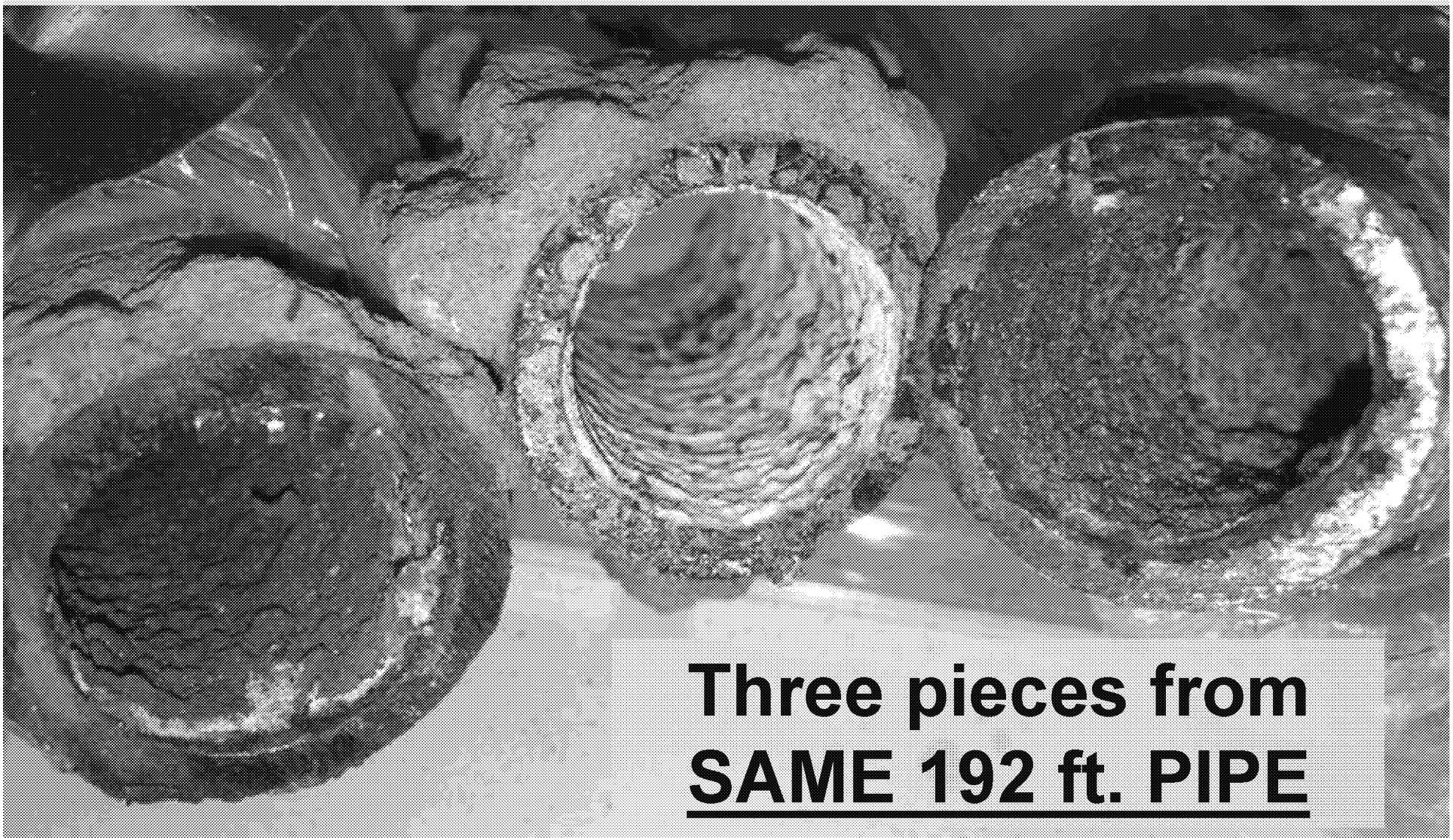
Recovered sections of galvanized pipe downstream of a lead pipe from EPA



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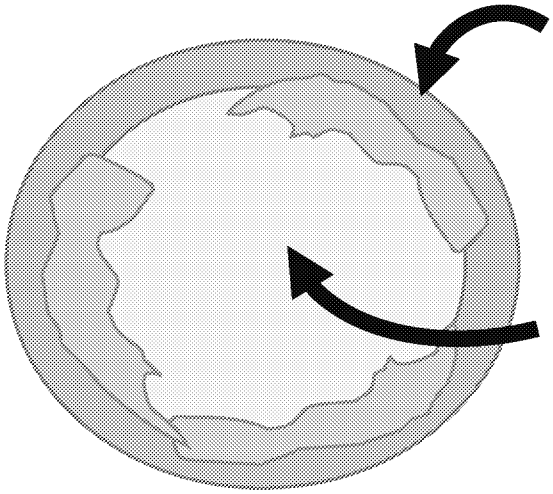
Determining lead contribution from GSL vs. LSL



GSL surface coating

Cd:Zn was 2.6 (*ppb:ppm*)

Pb:Zn was 18.2 (*ppb:ppm*)

April water samples

Cd:Zn was 2.6 (*ppb:ppm*)

Pb:Zn was 1824 (*ppb:ppm*)

Lead leached from LSL and sorbed to rust layers on GSL when supplied by DWSD

Similar to HDR Work in DC

An Analysis of the Correlation between Lead Released from Galvanized Iron Piping and the Contents of Lead in Drinking Water September 1, 2009

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HURLEY MEDICAL STUDY

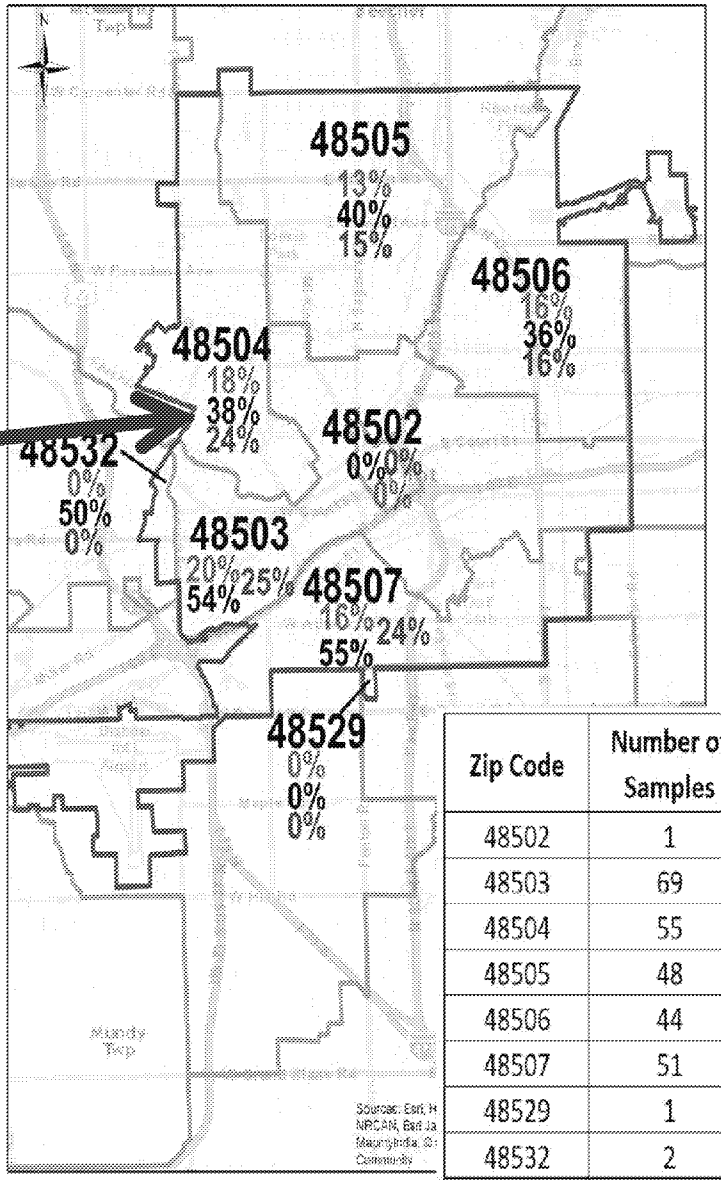
PEDIATRIC LEAD EXPOSURE IN FLINT, MI: CONCERNS FROM THE MEDICAL COMMUNITY

Higher Risk Zip Codes for High Lead in Water:

400-500% increase in elevated blood lead after the change in water

Flint, MI

Legend:
Blue %: Percent First Draw Samples over 15 ppb
Black %: Percent Any Samples over 5 ppb
Red %: Percent Any Samples over 15 ppb



Zip Code	Number of Samples
48502	1
48503	69
48504	55
48505	48
48506	44
48507	51
48529	1
48532	2
TOTAL	271

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Emily Garner

Dr. Otto Schwake

Legionella in Flint's waters

An unfortunate prediction that came true

The Building Plumbing Microbiome

Marc Edwards

Amy Pruden

W. Thomas Rice Professor

Joe Falkinham

Annie Pearce

Virginia Tech
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ICTAS
INSTITUTE *for* CRITICAL TECHNOLOGY *and* APPLIED SCIENCE *Virginia Tech*

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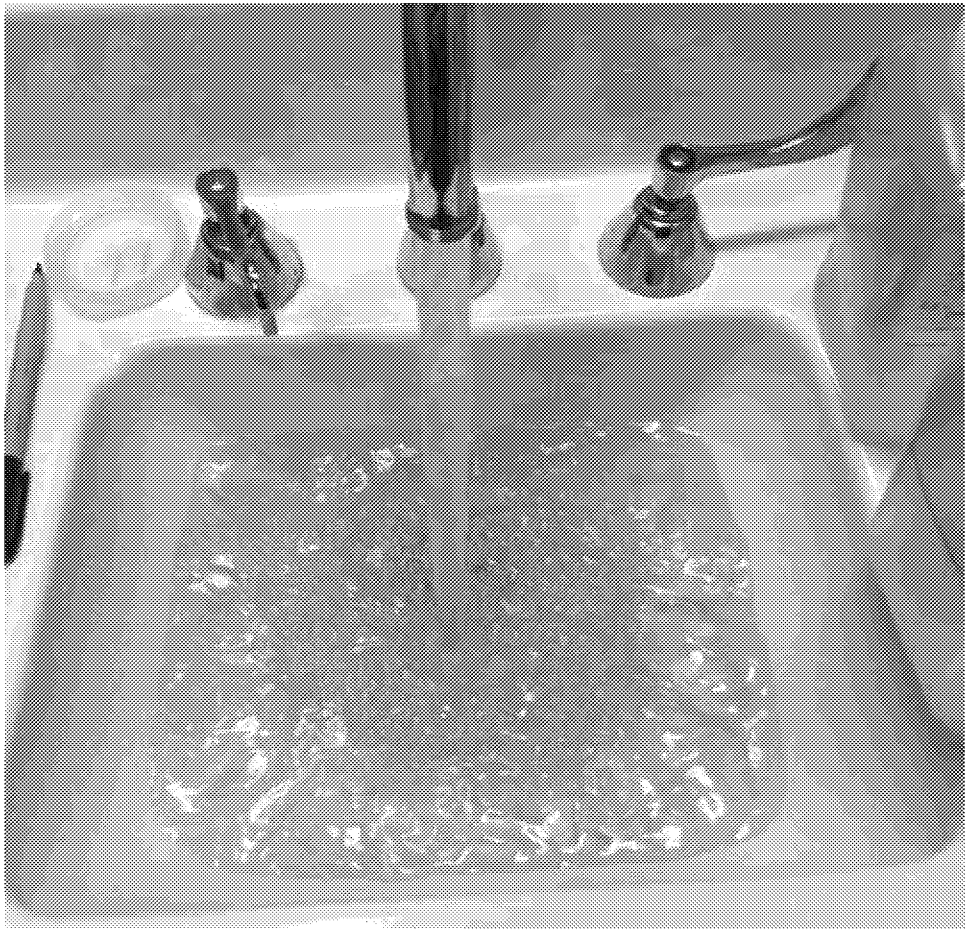
Lack of corrosion control = Increased *Legionella*

1. More bacteria “food” in river
2. Iron corrosion = more iron entering buildings’ pipes



Joyce Niu

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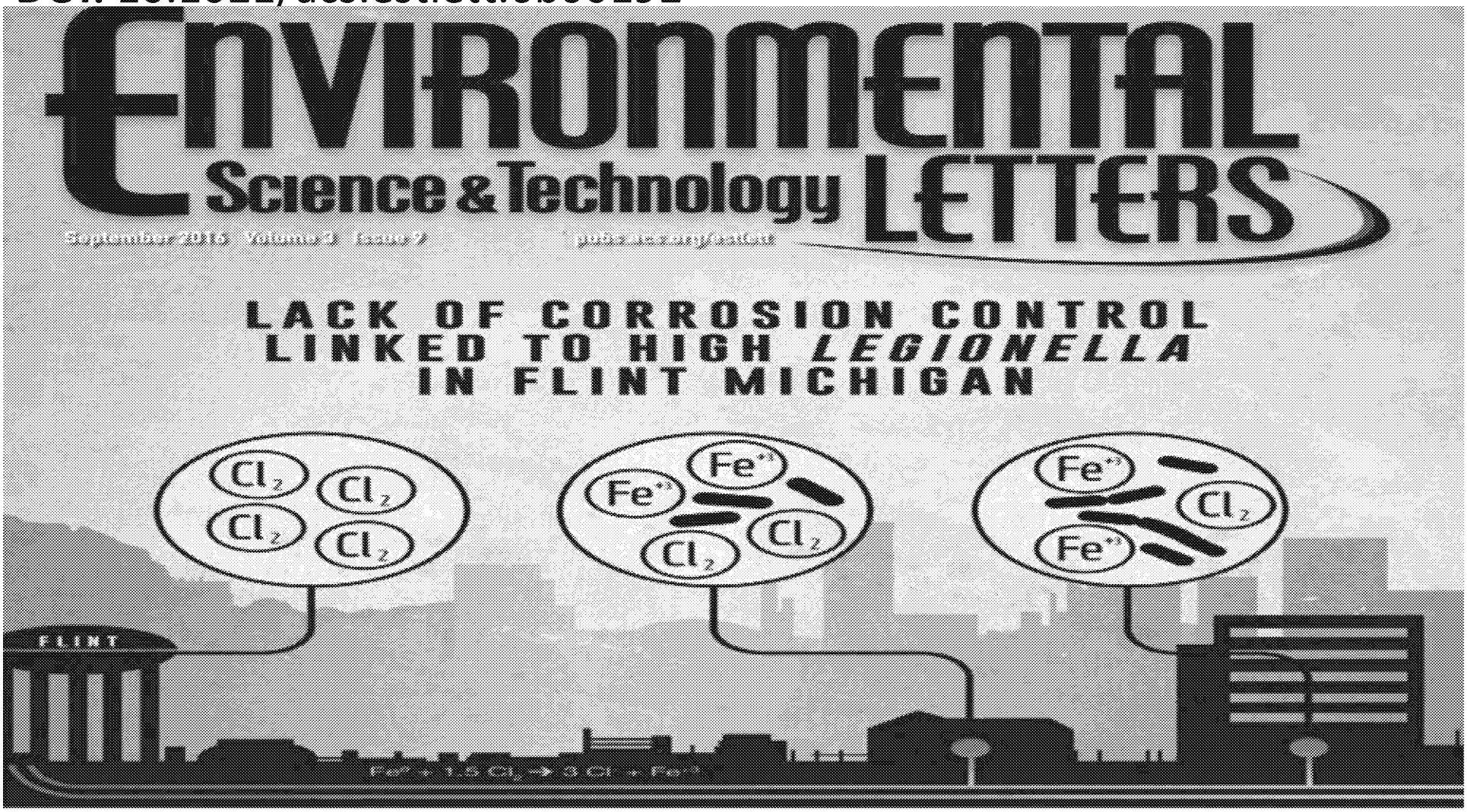
Lack of corrosion control = Increased *Legionella*

1. More bacteria “food” in river
2. Iron corrosion = more iron entering buildings’ pipes
3. High iron corrosion removed chlorine disinfectant

Legionella DNA Markers in Tap Water Coincident with a Spike in Legionnaires' Disease in Flint, MI

David Otto Schwake, Emily Garner, Owen R. Strom, Amy Pruden, and Marc A. Edwards* *Environ. Sci. Technol. Lett.*, Article ASAP

DOI: 10.1021/acs.estlett.6b00192



EPA-R5-2018-006908_0000400

Legionella in Flint: An Unfortunate Prediction that Came True

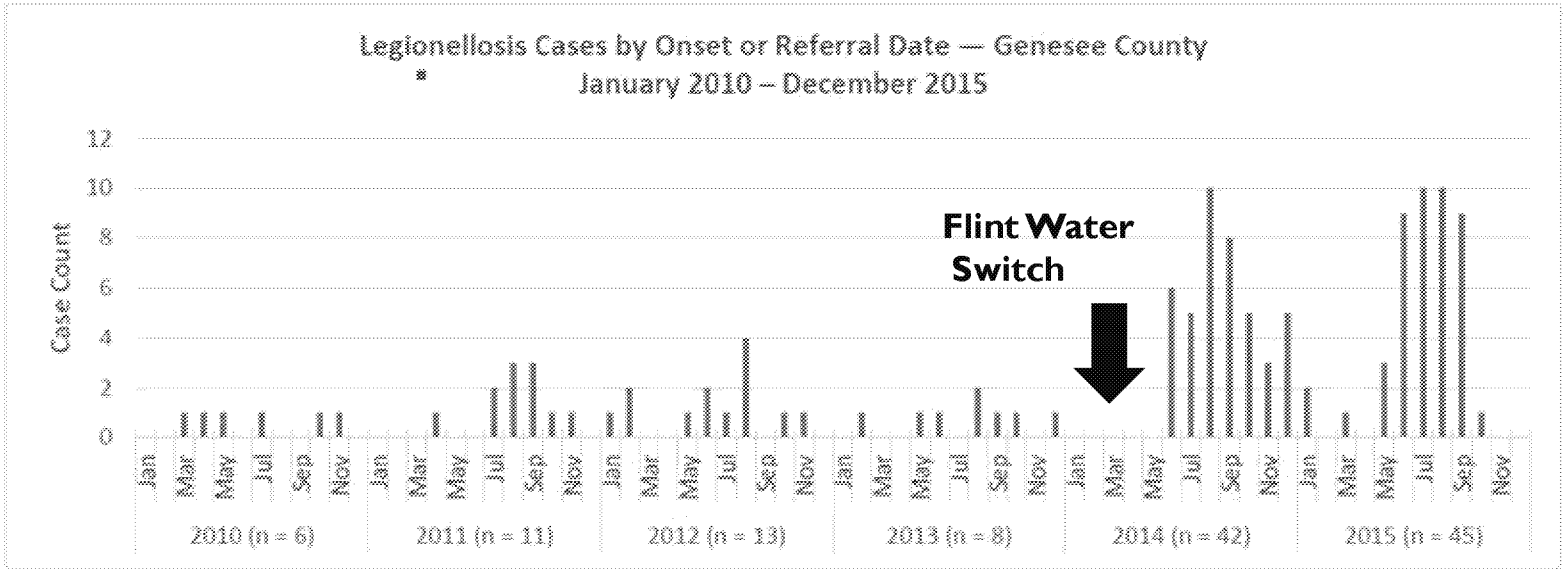
Flint learns of Legionnaires' disease spike as water crisis continues

By Ralph Ellis and Sara Ganim, CNN

Updated 8:13 PM ET, Wed January 13, 2016

Legionella Outbreak in Flint Leads to 87 Cases, 10 Deaths; Water Crisis Connection Unclear

Published Jan 14 2016 12:00 AM EST | By Ada Carr | weather.com



NSF RAPID: #1556258 Synergistic Impacts of Corrosive Water and Interrupted Corrosion Control on Chemical/Microbiological Water Quality: Flint, MI

OUTBREAK SEVERITY

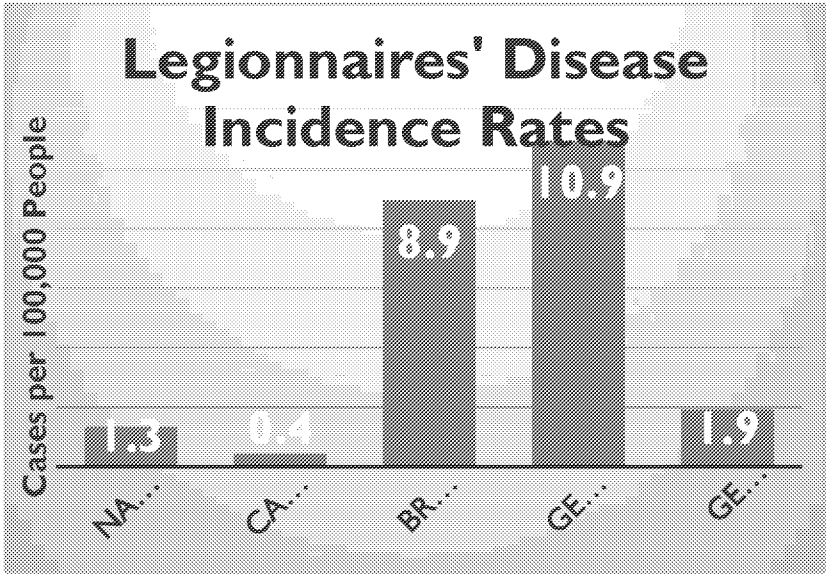
NYC Legionnaires' disease death toll hits double-digits as officials order inspection of all cooling towers, threaten penalties

A 0

By Ariana Eunjung Cha August 7, 2015

Major U.S. Legionnaires' Disease Outbreaks

LOCATION	DATE	CASES	DEATHS
WASHINGTON, DC	1965	81	14
PHILADELPHIA, PA	1976	221	34
BURLINGTON, VA	1980	85	16
CHICAGO, IL	2012	114	3
BRONX, NY	2015	124	12
GENESEE COUNTY	2014/2015	87	9



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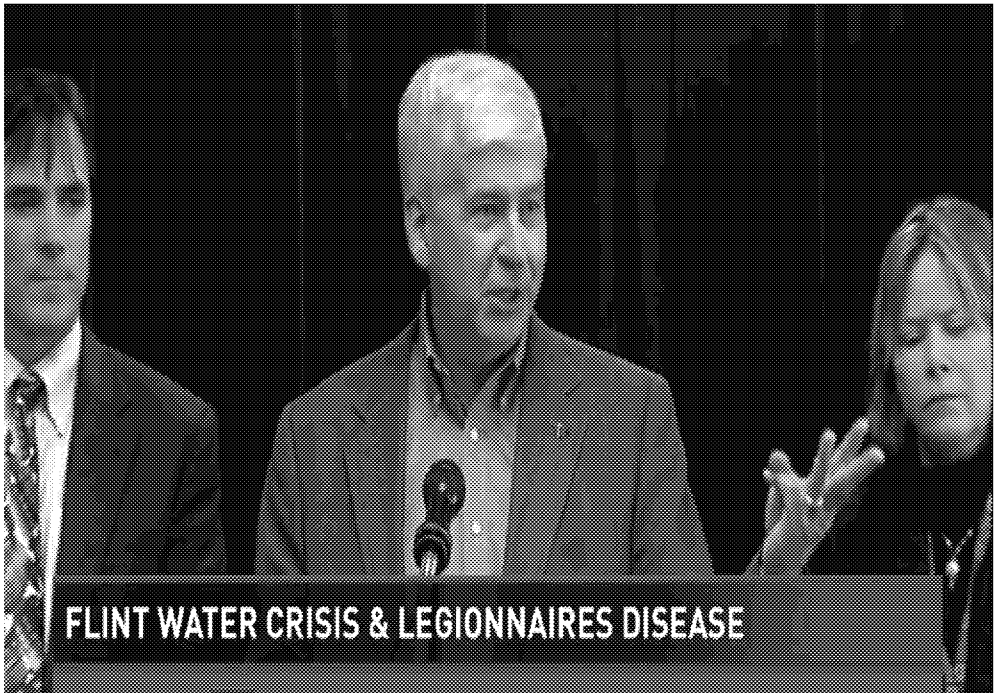
GOVERNMENT RESPONSE

'That just added to the disaster we were already facing,' Gov. Snyder says of Legionella spike in Flint area



2014: State and Federal Health officials knew Flint Residents were dying of Legionnaires Disease

The News-Herald / AP

Liane Shekter Smith, at the time the Michigan DEQ Chief of the Office of Drinking Water and Municipal Assistance.

OCTOBER 17, 2014

ANNOUNCEMENT WOULD 'INFLAME THE SITUATION'

Liane Shekter Smith, chief of the DEQ's Office of Drinking Water and Municipal Assistance, contacts Susan Bohm of the state Department of Health and Human Services about the Legionnaires' outbreak. Afterward, Bohm sends an email saying that Shekter Smith told her "there have been numerous complaints about the Flint water, that the Governor's Office had been involved and that any announcement by public health about the quality of the water would certainly inflame the situation."

Laurel Garrison (Centers for Disease Control and Prevention) to Genesee County health officials in an April 27, 2015,

"We are very concerned about this Legionnaires' disease outbreak," .."It's very large, one of the largest we know of in the past decade, and community-wide, and in our opinion and experience it needs a comprehensive investigation."

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LinkedIn

Jim Collins, director, Communicable Disease Division, Michigan Department of Community Health

JUNE 4, 2015

'OUTBREAK IS OVER'

Jim Collins of Michigan Public Health emails Laurel Garrison of the CDC: "The outbreak is over; the last reported case occurred in March, 2015. The lack of clinical Legionella isolates precludes our ability to link cases to an environmental source."

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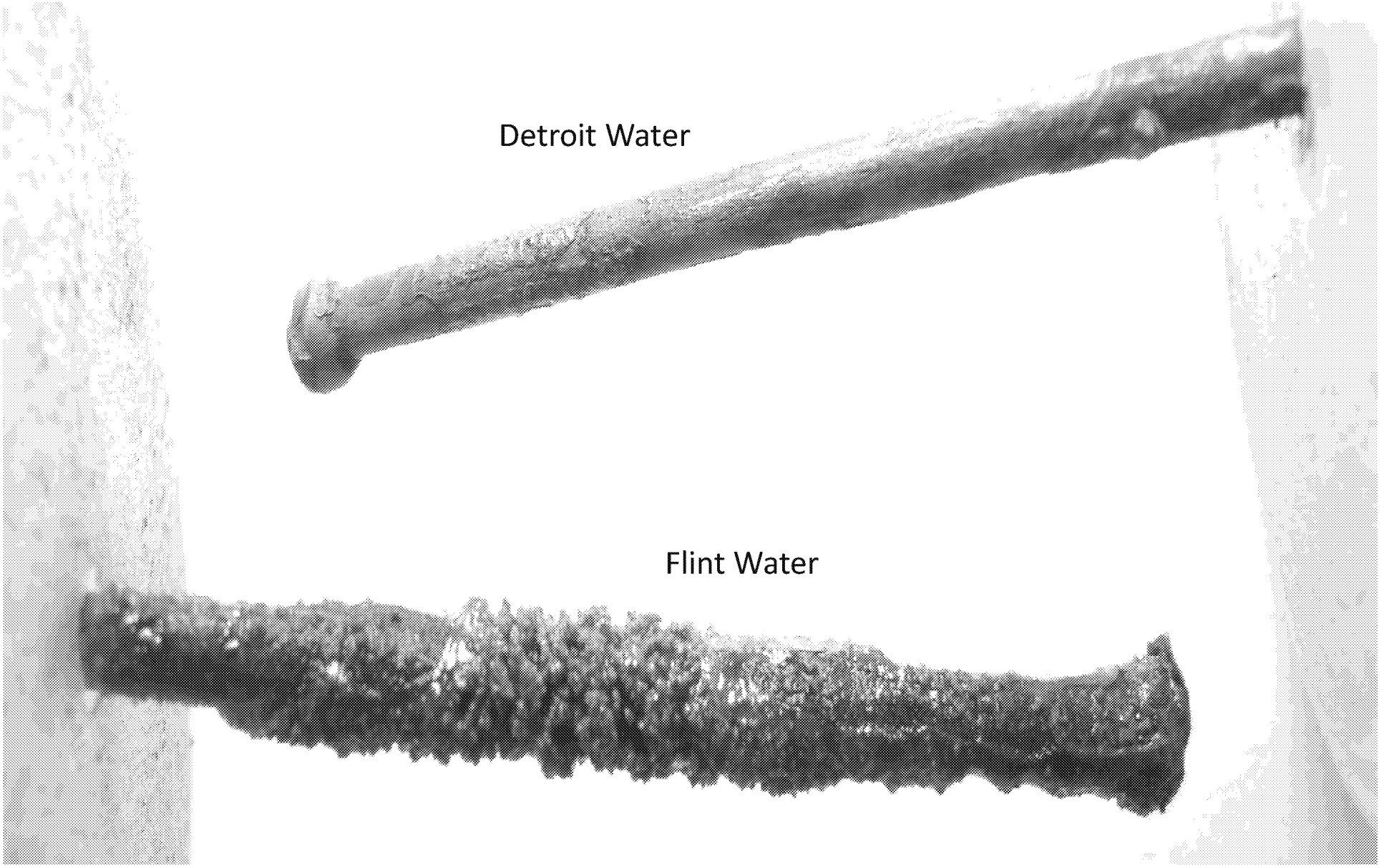
Corrosive Water:
Destroys Pipe Infrastructure

EPA-R5-2018-006908_0000407



Steel Exposed One Month to Detroit vs. Flint

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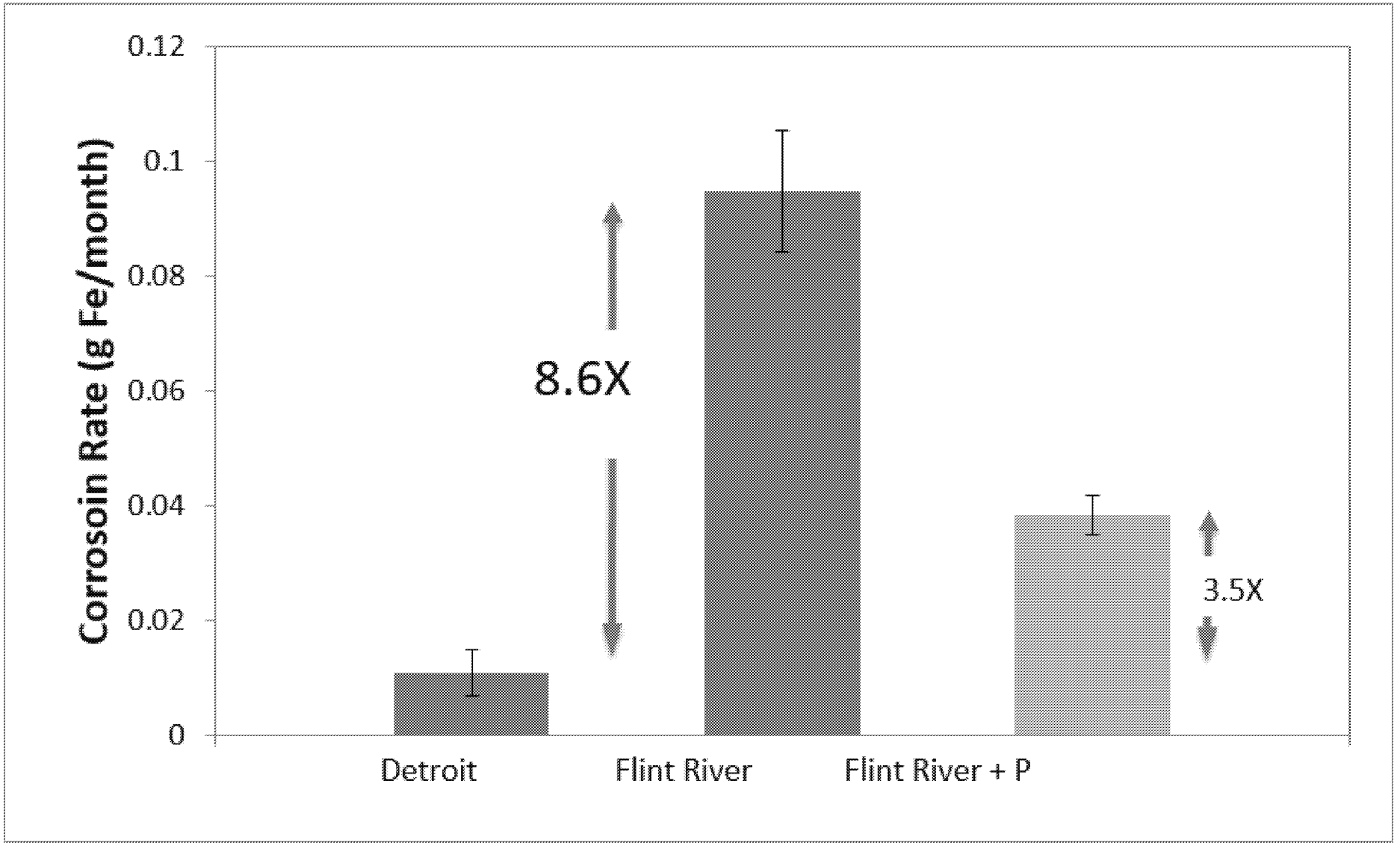
Corrosoin Rate (g Fe/month)
0.12
0.1
0.08
0.06
0.04
0.02
0
8.6X
3.5X
Detroit
Flint River
Flint River + P

https://twitter.com/thedailyshow/status/68813

EPA Region 5 Administrator Susan Hedman to resign in wake of the Flint water crisis

JAN 21, 2016

EPA-R5-2018-006908_0000412

8 civil servants indicted so far

EPA-R5-2018-006908_0000413

At least 33 US cities used water testing 'cheats' over lead concerns

Oliver Milman and Jessica Glenza

Thursday 2 June 2016 07.03 EDT

At least 33 cities across 17 US states have used water testing “cheats” that potentially conceal dangerous levels of lead, a Guardian investigation launched in the wake of the toxic water crisis in Flint, Michigan, has found.

EPA-R5-2018-006908_0000414

5,300 U.S. water systems are in violation of lead rules

By Sara Ganim, CNN Wed **June 29, 2016**

More than 5,300 water systems in America are in violation of the EPA's lead and copper rule, a federal regulation in place to safeguard America's drinking water from its aging infrastructure.

What's worse, the report reveals that the EPA is also aware that many utilities "game the system," using flawed or questionable testing methods in order to avoid detecting high levels of lead.

EPA-R5-2018-006908_0000415

Pittsburgh water: expensive, rust-colored, corrosive, and high in lead

Amid concerns about high levels of lead, the city's water agency is fielding

9/12/2016

<Stanley> States, the former water quality director at PWSA, ... said he felt **"I'd have been fired"** if Pittsburgh exceeded federal limits for lead.

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Flint's Lasting Legacy (6/15/2016)

..the Flint, MI water quality and lead contamination crisis are likely to impact consumer confidence in those responsible for protecting drinking water……the percent of….adult Americans worried a great deal about pollutants in drinking water is up..to 61 percent in 2016…..70 percent of Americans reported following the Flint crisis closely in April.

http://www.wcponline.com/2016/06/15/drinking-water-issues-worry-americans/

EPA-R5-2018-006908_0000417

Bottled Water to Outsell Soda for First Time, With Nod to Flint ...

*www.bloomberg.com/*Aug 2, 2016 - *Bottled water* will be more popular than soda for the first time in the U.S. ... But the expectation that future *sales* will rise has to do with another, ...]

Flint Crisis Partly Why Bottled Water Is Outselling Soda - Fortune

Aug 2, 2016 - *Bottled water sales* are set to surpass *sales* of soda for the first time in the U.S ... The recent crisis in *Flint*, Michigan that left children and parents ...

With No Amount of Lead Exposure Safe for Children, American Academy of Pediatrics Calls For Stricter Regulations 6/20/2016

ELK GROVE VILLAGE, IL –

State and local governments should take steps to ensure that water fountains in schools do not exceed water lead concentrations of 1 ppb.

EPA-R5-2018-006908_0000419

Why Michigan lead reforms don't call for even lower action level

Garret Ellison April 22, 2016 at 6:45 AM, updated April 22, 2016 at 10:08 AM

FLINT, MI — Marc Edwards found himself in an odd position recently....Instead of recommending that Michigan water utilities begin taking steps to control corrosion if lead concentrations exceed 5 parts-per-billion (ppb)... Edwards argued for 10 ppb

"if you went to 5 ppb, it was going to be way too expensive and difficult given other societal problems," he said. "We need to upgrade water mains. We need better roads."

EPA-R5-2018-006908_0000420

With Nod to Flint Crisis, Senate Weighs a $9 Billion Water Infrastructure Bill

By

A water tower in Flint, Mich., in 2015. Credit Joshua Lott for The New York Times

To date:
$67,000 per child

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Response to adversity/decline*

Who did this to us?

or

What did we do wrong?

*Bernard Lewis, 2002

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WASHINGTON DC
WATER LEAD CRISIS (2001-2004)

One of the worlds public health disasters WIKI-Congress

30X worse than Flint

Harm Covered up by EPA, CDC, DC WASA

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Lessons learned from DC?

- Defend Bad Actors/Attack Good People
- We Can Get Away With Anything
- Get better at covering up and avoiding responsibility for premise problems
  - lead/legionella
- Need a Conclusion? Get it by Falsifying the Science and Publish in JAWWA

= *RECIPE FOR DISASTER*

EPA-R5-2018-006908_0000424

March 3, 2014

JoAnn Galindo
Membership Marketing Coordinator
American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235

Dear Ms. Galindo,

I am writing in response to your email regarding cancellation of my membership.

<I resign over AWWA's policies on lead in water.>

Respectfully,

Miguel A. Del Toral

cc: Susan Franceschi, Chief Membership Officer
J. Alan Roberson, Director of Federal Relations

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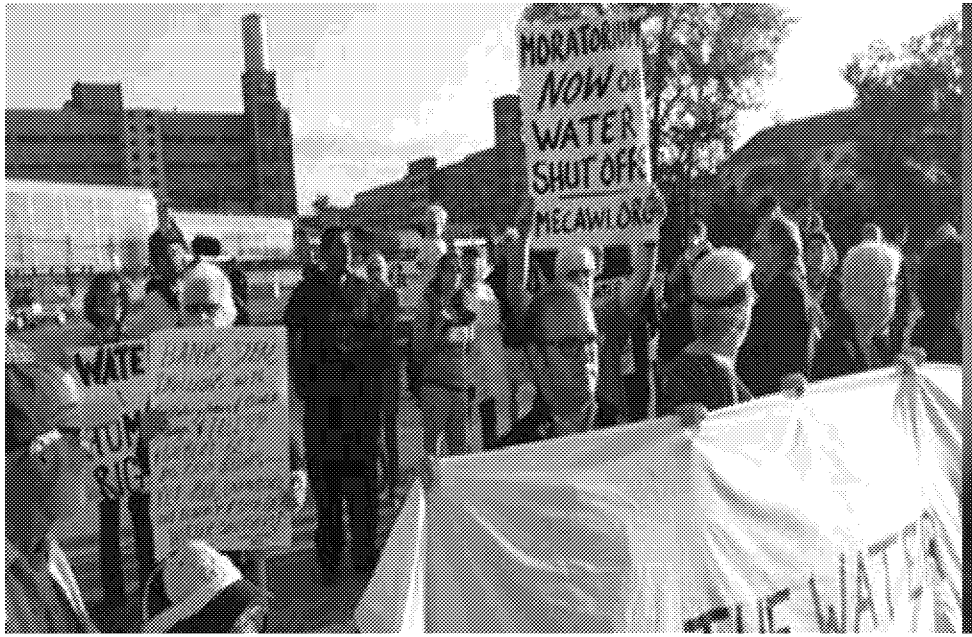
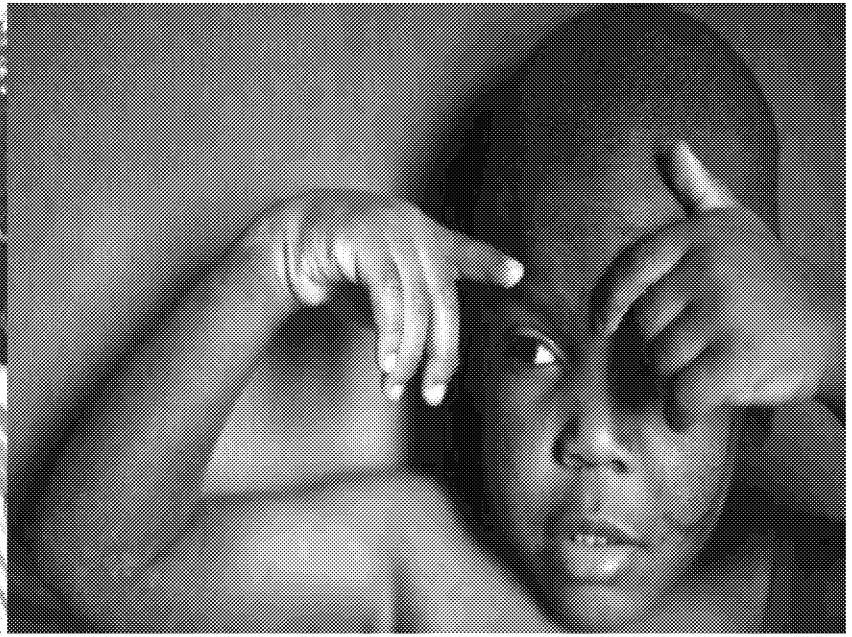
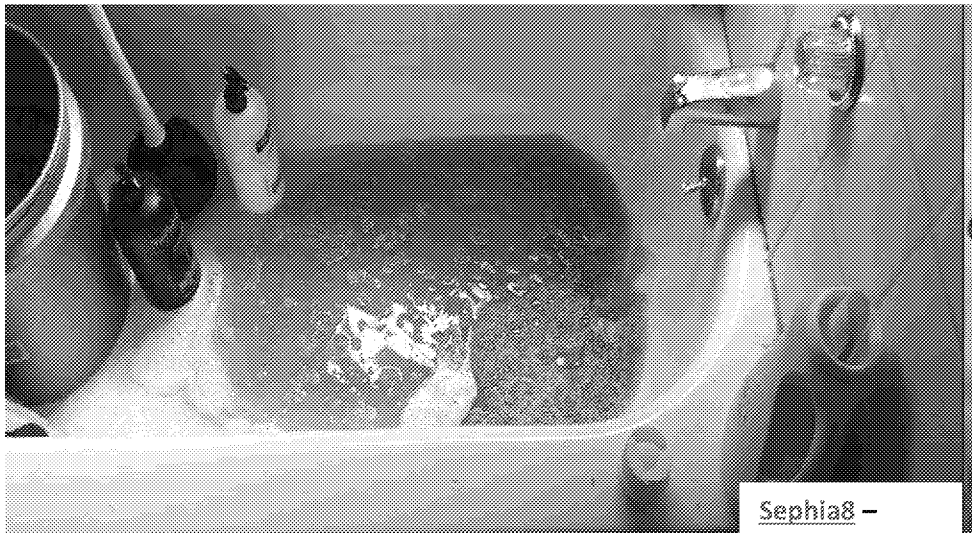
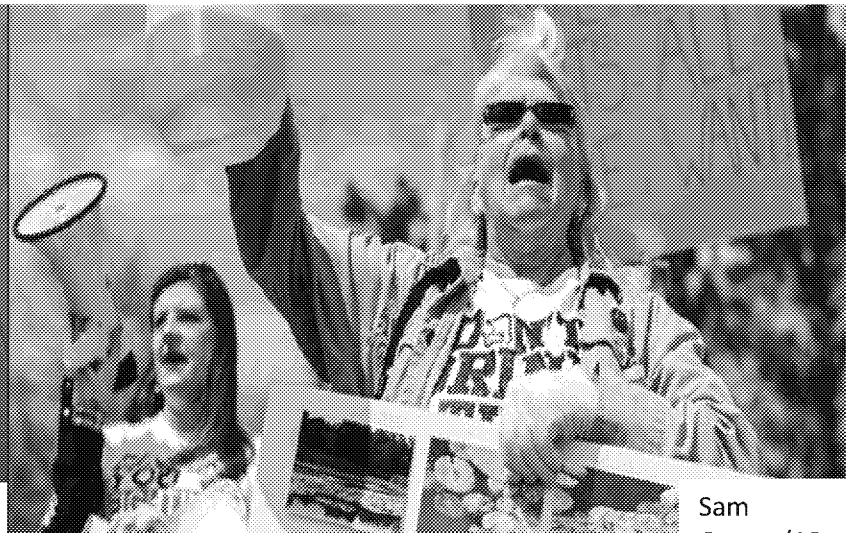




"Flint water is safe to drink."



Sephia8 –



Sam

EPA-R5-2018-006908_0000426

Country	Dollars per cubic meter
Flint MI	$3.84*
Germany	$1.91
Denmark	$1.64
Belgium	$1.54
Netherlands	$1.25
USA	$0.51
Australia	$0.50
South Africa	$0.47
Canada	$0.40

*
http://www.mlive.com/news/flint/index.ssf/2016/02/flints_water_rates_highest_in.html

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Who did this to us?

EPA-R5-2018-006908_0000428

Abel Wolman -
Environmental Engineer
father of disinfection in US

“If it weren’t for people like me, people like you would be dead.”

EPA-R5-2018-006908_0000429

WE CAN FIX THE WATER.....

Photograph: Joyce Niu, Min Tang, Pan Ji, Mariah Gnegy

.....BUT NOT THE LOST TRUST.

EPA-R5-2018-006908_0000430

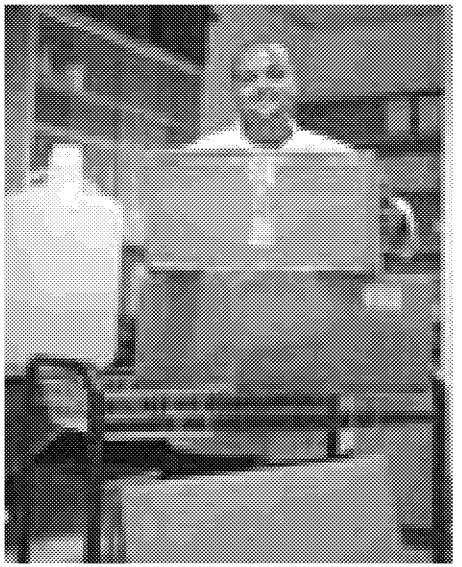
Research Team

Undergraduate Students:
Margaret **Carolan**, Kim **Hughes**, Rebecca **Jones**

Graduate Students (in alphabetical order):
Christina **Devine**, Emily **Garner**, Anurag **Mantha**, Rebekah **Martin**, Colin **Richards**, William **Rhoads**, Siddhartha **Roy**, Min **Tang**, Ni "Joyce" **Zhu**

Post-docs/Research Scientists (in alphabetical order): Drs. Brandi **Clark**, Dongjuan **Dai**, Sheldon **Masters**, Jeffrey **Parks**, Kelsey **Pieper**, David "Otto" **Schwake**, Fei **Wang**

Principal Investigators: Dr. Marc **Edwards**, Dr. Amy **Pruden**, Dr. Joseph **Falkinham III**



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8 person years volunteer effort Flintwaterstudy team